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Rotational forceps versus manual rotation and direct forceps: a retrospective cohort study

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Condensation

Rotational forceps are more successful manual rotation followed by direct forceps, and are associated with a higher rate of shoulder dystocia but not brachial plexus injury.

ABSTRACT

Rotational forceps versus manual rotation and direct forceps: a retrospective cohort study

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Objective

Rotational forceps and manual rotation followed by direct forceps are techniques used in the management of malposition of the fetal head in the second stage of labor. However, there is widespread debate regarding their relative safety and utility.

We aimed to compare the effectiveness and safety of rotational forceps with manual rotation followed by direct forceps, for management of fetal malposition at full dilation.

Study design

A retrospective cohort study in a single tertiary obstetric unit with >6000 births per year. We recorded and analysed outcomes of 104 sequential rotational forceps births births over 21 months (Jan 2010 – Sept 2012) and 208 matched chronologically sequential attempted manual rotations and direct forceps births (1:2 by number). Univariable and multivariable approaches used for statistical analysis. The main outcome measure was vaginal birth.

Results

The rate of vaginal birth was significantly higher with rotational forceps than with manual rotation followed by direct forceps (88.5% vs 82.2%, RR 1.17, 95 % CI 1.04 - 1.31, p = 0.017). Births by rotational forceps were associated with a significantly higher rate of shoulder dystocia (19.2% vs 10.6%, RR 2.35, 95% CI 1.23 - 4.47, p = 0.012), but not of neonatal injury. There were no significant differences in all other maternal and neonatal outcomes between the two modes of birth.

Conclusions

The use of rotational forceps was associated with a statistically significantly higher rate of vaginal birth, but also of shoulder dystocia, compared to manual rotation followed by direct forceps. This is the first study to demonstrate a statistically significant increase in the rate of shoulder dystocia following rotational forceps birth.

Keywords/ phrases

Manual rotation, operative birth, rotational forceps, shoulder dystocia

Introduction

Rotational forceps (RF) and manual rotation (MR) followed by direct forceps are both used to perform rotational operative vaginal birth. In the absence of strong evidence from randomised controlled trial to guide best practice, there remains debate regarding the safest and most effective method to assist birth in the presence of malposition.

The use of RF to achieve vaginal birth has been advocated by the Royal College of Obstetricians and Gynaecologists (1). In previous generations, higher rates of complications, such as delayed onset of respiration, birth trauma or neonatal irritability, were reported following the use of RF (2). However, these data come from small cohort studies without appropriate control groups of babies delivered with other rotational operative birth method. Nonetheless, fear of increased complication rates compounded by a lack of supervised training to achieve independent competent practice, has led large numbers of current day obstetricians to discontinue or never acquire skills in the use of RF (3,4). Renewed interest in the safety and efficacy of RF is emerging (3,5-9). The use of RF may be associated with high rates of successful vaginal birth and comparable or lower rates of adverse outcomes than alternative modes of birth (10-14).

We conducted a retrospective cohort study to determine differences in maternal and neonatal outcomes between RF and MR followed by direct forceps, in a unit with regular interprofessional training in birth emergencies.

Materials and Methods

This was a retrospective cohort study of rotational operative vaginal births which took place between January 2010 and September 2012 in a single tertiary-level maternity unit in Bristol, UK with more than 6500 births per annum.

All rotational operative births conducted in this hospital were performed or directly supervised by senior obstetricians qualified to perform mid-cavity rotational operative vaginal birth (OVB) independently. Obstetricians with ≥4 years training (Speciality Trainee (ST) 4+) would usually perform MR followed by direct forceps independently. All attempts at RF were either supervised or conducted by a consultant, or undertaken independently by a senior trainee (ST6-7) who had previously been assessed as competent by the consultant team to perform RF without supervision.

All births conducted in the study period were assessed for eligibility. Eligible participants were women who had singleton, cephalic pregnancies with persistent malposition at full cervical dilation (occipito-transverse or occipito-posterior) and attempted RF or attempted MR followed by direct forceps births. Every attempted RF birth and the next two sequential MR followed by direct forceps attempts were electronically identified and extracted in order to obtain a comparative cohort frequency-matched 1:2.

Demographic, clinical variable factors and outcomes were extracted from maternity paper notes and electronic medical records (EuroKing Software, Chertsey, UK). Neonatal data was extracted from the Badger electronic database (Clevermed Ltd, Edinburgh, UK).

Information on the following maternal characteristics were collected: maternal age, body mass index (BMI) (<25, 25 to 30, ≥30 kg/m^2), parity, history of previous Caesarean or vaginal birth, length of gestation (<37 weeks, ≥37 weeks), duration of first and second stage (minutes), indication for birth (presumed fetal compromise, delay in 2nd stage), position of fetal head (right occipito-anterior, right occipito-transverse, right occipito-posterior, occipito-posterior, left occipito-posterior, left occipito-transverse, left occipito-anterior, occipito-anterior), station of fetal head (at ischial spines, +1cm below ischial spines, +2cm below ischial spines), presence and degree of moulding (none, +, ≤++), presence and degree of caput (none, 1cm, 2cm) , analgesia (epidural block, spinal block, pudendal block), baby birth weight (<4 Kg, ≥4 Kg), grade of operator (ST 1 to 2, ST 3, ST 4 to 5, ST 6 to 7, consultant), and seniority of supervisor if applicable (ST 6 to 7, consultant).

The primary outcome was vaginal birth. A birth ultimately performed with a Caesarean section was considered as unsuccessful vaginal birth. Secondary maternal outcomes were: diagnosis of anal sphincter injury, postpartum haemorrhage (≤1litre, >1litre) anaemia (Hb < 105g/dl vs ≥105g/dl) within 24 hours following birth, occurrence of maternal sepsis, maternal length of stay in hospital (days). Secondary neonatal outcomes were: umbilical artery or vein pH (≥7.10, <7.10), Apgar score at 1 min (≥3, <3), Apgar score at 5 min (≥7, <7), Apgar score at 10 min (≥7, <7), occurrence of shoulder dystocia, jaundice, transient tachypnoea of the newborn, sepsis, seizure, any neonatal injury (including cephalohaematoma, retinal haemorrhage, facial injury and bony injury, and any nerve injury), admission to neonatal intensive care unit, and length of admission (days).

Statistics

Frequency and percentage of demographic, clinical variable factors, maternal and neonatal outcomes were described and tabulated by rotation technique. Log-binomial regressions were used to derive relative risk and compare the prevalence rates between the two rotation technique groups. Regressions were adjusted for maternal age, parity, BMI, length of gestation, first and second stage duration, supervisor grade, fetal position in-utero and birth weight. The group difference in length of hospitalisation was investigated with an ordered logistic regression. Comparison from unadjusted regression was reported when the frequency of the outcome of interest was low. Statistical significance <0.05 was considered as evidence of group difference. Analyses were performed using Stata® software, version 13 (StataCorp, College Station, Texas, USA). We used the STROBE guideline and checklist to report the study (15).

Approval for this study was given by the Clinical Governance Department of North Bristol NHS Trust in February 2012 (No: 23849).

Results

The sample comprised 312 women who had attempted rotational OVBs by experienced obstetricians during the 21-month study period; 104 attempted RF births and 208 attempted births by MR followed by direct forceps. The choice of technique used to assist birth (RF or MR followed by direct forceps) was decided by the most senior obstetrician in attendance at the birth. There were no attempts to apply a second instrument to achieve a vaginal birth in this study if OVB with the first instrument failed. Mean maternal age was 29.6 (standard deviation 5.9 years), mean BMI was 24 (SD 4.5), 86% of women had not had a previous vaginal birth, and 50% were delivered due to a prolonged second stage of labour. All demographic data are summarised in Table 1.

Outcomes for women who had an attempted rotational OVB by rotation technique used are given in Table 2. The successful vaginal birth rate was 88.5% for RF and 82.2% for MR followed by direct forceps. This difference was significant following adjustment (RR 1.17, 95% CI; 1.02 – 1.27, p = 0.017).

Outcomes of babies who had an attempted rotational OVB by rotation technique used are given in Table 3. Births by RF were associated with a significantly higher rate of shoulder dystocia (19.2% vs 10.6%, RR 2.35, 95% CI; 1.23 - 4.47, p = 0.009), but none of the babies in the study sustained a birth injury (temporary or permanent) secondary to dystocia.

There was no evidence of significant differences in all other adjusted maternal or neonatal outcomes by mode of birth – detailed in Tables 2 and 3 respectively. Particularly relevant continuous fetal outcome data (regarding umbilical cord pH and Apgar score at 5 minutes) are given in Figures 1 & 2 respectively. While there were differences in absolute rates of some outcomes (such as maternal anaemia and sepsis) by delivery method, these were not statistically significant. Where patient numbers were not sufficient to conduct comparisons, no statistical interpretation is given and data are presented for descriptive purpose in Tables 2 and 3. All outcomes are given unadjusted in Table 4.

Comment

This study shows that rotational forceps are more successful than MR followed by direct forceps for achieving successful rotational operative vaginal birth. In particular it shows that this effect is preserved after adjusting for the seniority of the supervising accoucheur – RF was not more successful purely because it was performed by more senior obstetricians.

This difference in effectiveness has clinical implications. Increased adverse outcomes for mothers and babies occur when sequential instruments are used for vaginal birth, such as increased anal sphincter trauma or increased risk of umbilical artery pH <7.10 (16). Similarly increased rates of complications are observed when birth is achieved by Caesarean after failed instrumental attempt or during the second stage of labour (11), (17). Therefore the use of RF in preference to MR followed by direct direct forceps could reduce these adverse outcomes. Training in the use of rotational forceps might help increase the usage of RF, however this study shows potential caveats. Moreover, despite the statistical significance of this finding, it is important to place it within a clinical context – while an increase in vaginal birth rate of 6% is desirable, it should be interpreted in light of the findings of possible increases in adverse outcomes, in particular shoulder dystocia.

This study is the first in the published literature to demonstrate a statistically significant difference in shoulder dystocia rates between RF and MR followed by direct forceps. We note that these rates are higher than those quoted in recent studies of rotational birth. Tempest et al. reported shoulder dystocia risk of 6.2% following RF and Aiken et al. reported a rate of 2.7% following pooled RF and rotational ventouse (11,13). Finally, Bahl et al. reported a shoulder dystocia rate of 6.2% following RF and 4.9% following MR followed by direct forceps (14). The reason for the higher rate of shoulder dystocia across both cohorts in our study is not clear and may be related to a lower threshold for diagnosing shoulder dystocia within the unit in which the study was performed. The unit in which this study was conducted has reported a 3.3% rate of shoulder dystocia in all vaginal births over a three-year period including this study (2009 to 2012) (18), which is substantially higher than other comparable units – in a unit of similar size in 2004 to 2008, Walsh et al. found a 1.7% rate of shoulder dystocia (19). Moreover, we found no adverse neonatal neurological outcomes associated with shoulder dystocia, contrary to other studies; Tempest et al. reported 10 cases of temporary Erb's Palsy and Burke et al. reported 1 case of permanent Erb's Palsy (10,11). This combination of a higher rate of shoulder dystocia but lower rates of resultant nerve injury may reflect regular training in shoulder dystocia, which has been practiced in the studied unit since 2002 (20,21). It could also reflect overdiagnosis of innocuous cases that would have had good outcomes regardless of the manoeuvres employed by the attending staff (19). However, it has been shown that in maternity units with embedded practical teaching in the management of obstetric emergencies, shoulder dystocia is better recognised and documented (22), better managed (20), and can be associated with zero rates of permanent brachial plexus injuries (18).

While our results may reflect a degree of overdiagnosis, they also add to the well-established association between a higher rate of shoulder dystocia and operative vaginal birth (both ventouse and forceps, rotational or not) (23). Previous reviews have posited that the act of rotational delivery may in itself attenuate the normal mechanisms of fetal rotation in the pelvis, thereby increasing the risk of a shoulder dystocia (23). While our study cannot provide direct evidence for any theoretical mechanism, it does illustrate the marked increase in shoulder dystocia across all groups of rotational operative vaginal births utilising forceps.

Importantly, the rates of anal sphincter injury were not significantly different and are comparable to other recent studies in this field (11-14,24,25).

The strengths of this study include that it includes all attempted RF births performed in a large obstetric unit with a standardised and safe clinical routine, allowing a robust comparison between the two techniques.

A potential criticism is that the study was a retrospective cohort study with its inherent limitations. We have reduced the effects of confounding by adjusting for anticipated factors as listed in the Materials and Methods section. Caput, station and use of analgesia were not adjusted for. Caput and station were not adjusted for as they are subjectively measured and may vary significantly between operators. Use of analgesia was not adjusted for as it was not substantially different between the two groups (never more than a 5% difference in analgesia use between RF and MR followed by DF groups). As the sample size was relatively small, we were unable to adjust for all possible confounders and maintain a statistically meaningful method. We therefore adjusted for as many exposures which were both objective and differed significantly between the group.

Furthermore, the study only examined immediate complications of birth, and did not look at longer-term outcomes such as dyspareunia, prolapse, incontinence or subsequent fear of childbirth. These are important and should be taken into account in any discussion around OVB. Recent individual studies (10-14) have not been of sufficient size to allow comparison of rarer outcomes, such as retinal haemorrhage, cephalohaematoma or permanent neurological injury, and a recent meta-analysis did not consider complications individually but as a composite (26).

We also acknowledge that the potentially small size of this study (n = 302) and its single site of recruitment mean that the study population may not be representative of wider obstetric outcomes.

Whereas this study was not powered for rarer events such as facial nerve palsy, the cases described can contribute to the power of any future meta-analyses of outcomes in rotational OVB and have therefore been reported here.

There remains debate around the place of rotational forceps in modern obstetric practice. This study adds to other recent studies (10-14), in quantifying the superior efficacy of RF over MR followed by direct forceps birth for malposition in the second stage of labour.

There remains reluctance to adopt RF as an accepted technique for rotational OVB. Junior obstetricians in particular need confidence and familiarity with the safe use of rotational forceps (9,27,28). This could be learnt under the instruction of an experienced senior obstetrician in real cases (29). Simulation could also play an important role in beginning learning in a safe environment (30); it has been shown to improve trainee use of direct forceps (31) and we hypothesise that the same improvement in use is likely to apply to rotational forceps as well. The safe use of rotational forceps might deserve a more important place in current obstetric curricula.

In conclusion, this study shows that both techniques, rotational forceps, and manual rotation followed by direct forceps, are effective and safe in experienced or supervised hands. The results confirm the superior effectiveness of rotational forceps in expediting vaginal birth and suggest the need for more practical training, to ensure that effectiveness is accompanied by safety.

Conflict of Interests Statement: SO'B is a member of the BD Odon Device Scientific Advisory Board, which advises on the development of the BD Odon Device, a novel device for operative vaginal birth. Members of the Board receive no honoraria, and solely receive reimbursement of travel and accommodation expenses to attend meetings of the Board.

All other authors (FD, EL, KC, SE & DS) have no conflict of interest.

Role of funding source

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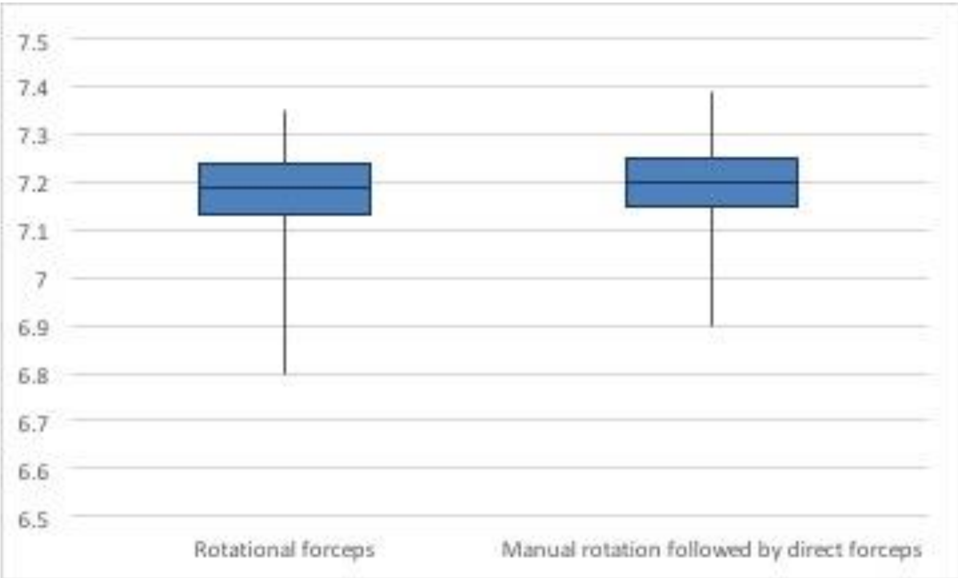
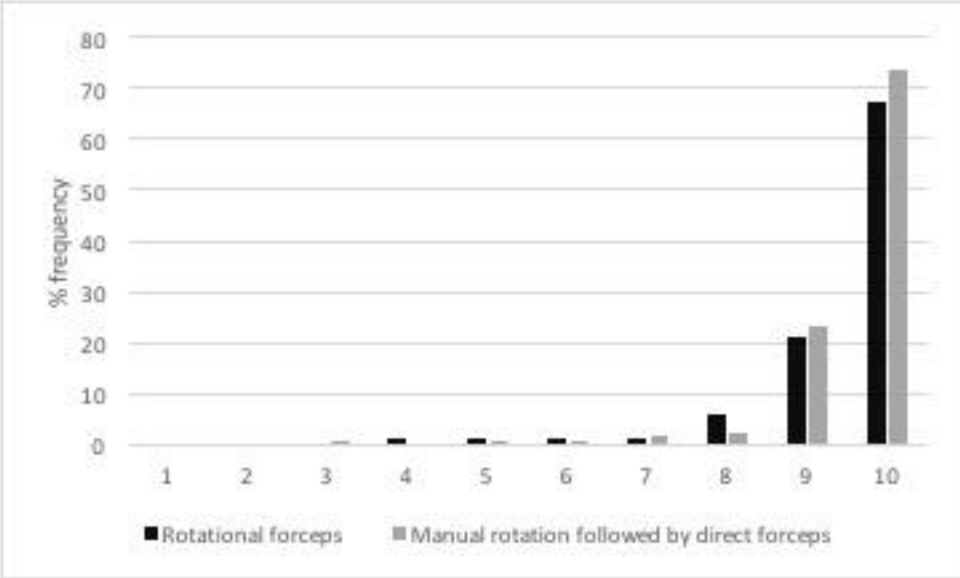
Figure legend:

Figure 1 - Umbilical arterial pH following OVB

Figure 2 - Apgar scores at 5 minutes by delivery method



Figr-1


80
70
60
50
40
30
20
10
0
% frequency
1
2
3
4
5
6
7
8
9
10
Rotational forceps
Manual rotation followed by direct forceps

Figr-2

Table 1. Demographic details of women who had an attempted rotational operative vaginal birth by rotation technique used

		Total n=302 (%)	MR n=208 (%)	RF n=104 (%)
Maternal age	<35y	253 (81.1)	170 (81.7)	83 (79.8)
	>=35y	59 (18.9)	38 (18.3)	21 (20.2)
Parity	previous pregnancy	53 (17.0)	34 (16.4)	19 (18.3)
	nulliparity	259 (83.0)	174 (83.7)	85 (81.7)
Previous normal vaginal delivery	no previous NVD	269 (86.2)	179 (86.1)	90 (86.5)
	previous NVD	43 (13.8)	29 (13.9)	14 (13.5)
Previous Caesarean section delivery	no previous CS	298 (95.5)	202 (97.1)	96 (92.3)
	previous CS	14 (4.5)	6 (2.9)	8 (7.7)
BMI	<25	183 (58.7)	116 (55.8)	67 (64.4)
	25 to 30	89 (28.5)	66 (31.7)	23 (22.1)
	≥30	38 (12.2)	25 (12.0)	13 (12.5)
	unknown	2 (0.6)	1 (0.5)	1 (1.0)
Length of gestation	<37 weeks	11 (3.5)	7 (3.4)	4 (3.9)
	>=37 weeks	284 (91.0)	185 (88.9)	99 (95.2)
	unknown	17 (5.5)	16 (7.7)	1 (1.0)
Reasons for delivery	fetal compromise	114 (36.5)	75 (36.1)	39 (37.5)
	delay	156 (50.0)	102 (49.0)	54 (51.9)
	compromise and delay	40 (12.8)	29 (13.9)	11 (10.6)
	unknown	2 (0.6)	2 (1.0)	0 (0.0)
First stage duration	<=12 hours	219 (70.2)	145 (69.7)	74 (71.2)
	> 12 hours	74 (23.7)	49 (23.6)	25 (24.0)
	unknown	19 (6.1)	14 (6.7)	5 (4.8)
Second stage duration	<=2 hours	108 (34.6)	74 (35.6)	34 (32.7)
	> 2 hours	190 (60.9)	122 (58.7)	68 (65.4)
	unknown	1 4(4.5)	12 (5.8)	2 (1.9)
Baby in-utero position	OT	169 (54.2)	125 (60.1)	44 (42.3)
	OP	122 (39.1)	65 (31.3)	57 (54.8)
	LOA/ROA	21 (6.7)	18 (8.7)	3 (2.9)
Station	-1	1 (0.3)	1 (0.48)	0 (0)
	0	174 (57.6)	129 (62)	45 (43)

	+1	130 (43)	81 (38.9)	49 (47.1)
	+2	10 (3.3)	2 (0.9)	8 (7.6)
Presence of caput	None	66 (21.8)	45 (21.6)	21 (20.1)
	+	129 (42.7)	81 (38.9)	48 (46.1)
	≥++	120 (39.7)	87 (41.8)	33 (31.7)
Analgesia	Epidural	216 (71.5)	147 (70.6)	69 (66.3)
	Spinal	94 (31.1)	59 (28.3)	35 (33.6)
	Pudendal	8 (2.6)	0 (0)	8 (3.8)
Birth weight	<4kg	255 (81.7)	169 (81.3)	86 (82.7)
	≥4kg	56 (18.0)	38 (18.3)	18 (17.3)
	unknown	1 (0.3)	1 (0.5)	0 (0.0)
Operator (years of training)	1 to 2	19 (6.1)	18 (8.7)	1 (1.0)
	3	83 (26.6)	68 (32.7)	15 (14.4)
	4 to 5	80 (25.6)	57 (27.4)	23 (22.1)
	6 to 7	90 (28.9)	48 (23.1)	42 (40.4)
	consultant	40 (12.8)	17 (8.2)	23 (22.1)
Supervision	nil	191 (61.2)	121 (58.2)	70 (67.3)
	trainee in years 6 to 7	68 (21.8)	60 (28.9)	8 (7.7)
	consultant	53 (17.0)	27 (13.0)	26 (25.0)

Table 2. Outcomes of women who had an attempted rotational operative vaginal birth by rotation technique used

		Total n=302 (%)	**MR** n=208 (%)	**RF** n=104 (%)	**Adjusted RR*** **(95% CI)**	**p-value**
Vaginal birth	vaginal birth	263 (84.3)	171 (82.2)	92 (88.5)	1.17 (1.04 - 1.31)	0.01
PPH	>1 litre	165 (52.9)	115 (55.3)	50 (48.1)	0.88 (0.68 - 1.13)	0.31
Anal sphincter trauma	yes	22 (7.1)	12 (5.8)	10 (9.6)	1.99 (0.90 - 4.39)	0.08
Length of hospitalisation	1 day	141 (45.2)	98 (47.1)	43 (41.4)		
	4-5 days	30 (9.6)	19 (9.1)	11 (10.6)		
	6+ days	20 (6.4)	13 (6.3)	7 (6.7)		
	unknown	4 (1.3)	3 (1.4)	1 (1.0)		
Anaemia	yes	14 (4.5)	6 (2.9)	8 (7.7)	2.52 (0.70 - 9.07)	0.15
	unknown	1 (0.3)	1 (0.5)	0 (0.0)		
Maternal Sepsis	yes	19 (6.1)	11 (5.3)	8 (7.7)	1.92 (0.78 - 4.71)	0.15
	unknown	1 (0.3)	1 (0.5)	0 (0.0)		
Other complication	yes	12 (3.9)	7 (3.4)	5 (4.8)	1.53 (0.51 - 4.57)	0.45
	unknown	1 (0.3)	1 (0.5)	0 (0.0)		

*assessed with log-binomial regression

Table 3. Outcomes of babies who had an attempted rotational operative vaginal birth by rotation technique used

		Total n=302 (%)	MR n=208 (%)	RF n=104 (%)	Adjusted RR* (95% CI)	p-value
Cord gas(pH)	<7.1	41 (13.1)	23 (11.1)	18 (17.3)	1.44 (0.79 - 2.61)	0.232
	unknown	44 (14.1)	32 (15.4)	12 (11.5)		
Apgar@1mn	<=3	8 (2.6)	2 (1.0)	6 (5.8)		
	unknown	5 (1.6)	4 (1.9)	1 (1.0)		
Apgar@5mn	<7	7 (2.2)	3 (1.4)	4 (3.9)		
	unknown	4 (1.3)	3 (1.4)	1 (1.0)		
Apgar@10mn	<7	4 (1.3)	2 (1.0)	2 (1.9)		
	unknown	4 (1.3)	3 (1.4)	1 (1.0)		
Shoulder dystocia	yes	42 (13.5)	22 (10.6)	20 (19.2)	2.35 (1.23 - 4.47)	0.009
Cephalohaematoma	no	309 (99.0)	205 (98.6)	104 (100.0)		
	unknown	3 (1.0)	3 (1.4)	0 (0.0)		
Bony injury	no	309 (99.0)	205 (98.6)	104 (100.0)		
	unknown	3 (1.0)	3 (1.4)	0 (0.0)		
Facial palsy	no	308 (98.7)	204 (98.1)	104 (100.0)		
	yes	1 (0.3)	1 (0.5)	0 (0.0)		
	unknown	3 (1.0)	3 (1.4)	0 (0.0)		
Other nerve problem	no	309 (99.0)	205 (98.6)	104 (100.0)		
	unknown	3 (1.0)	3 (1.4)	0 (0.0)		
TTN	yes	6 (1.9)	4 (1.9)	2 (1.9)		
	unknown	3 (1.0)	3 (1.4)	0 (0.0)		
Jaundice	yes	11 (3.5)	9 (4.3)	2 (1.9)	1.07 (0.18 - 6.38)	0.94
	unknown	3 (1.0)	3 (1.4)	0 (0.0)		
Neonatal sepsis	yes	13 (4.2)	6 (2.9)	7 (6.7)	2.18 (0.52 - 9.17)	0.286
	unknown	3 (1.0)	3 (1.4)	0 (0.0)		
Seizure	no	309 (99.0)	205 (98.6)	104 (100.0)		
	unknown	3 (1.0)	3 (1.4)	0 (0.0)		
Other complication	yes	13 (4.2)	8 (3.9)	5 (4.8)	1.08 (0.32 – 3.61)	0.86

	unknown	3 (1.0)	3 (1.4)	0 (0.0)		
NICU admission	admitted	26 (8.3)	17 (8.2)	9 (8.7)	1.01 (0.40 - 2.52)	0.98
	unknown	5 (1.6)	5 (2.4)	0 (0.0)		

*assessed with log-binomial regression

Table 4. Unadjusted maternal and neonatal outcomes in relation to mode of attempted rotational operative vaginal birth

		Total n=302(%)	**MR** n=208(%)	**RF** n=104(%)	**Unadjusted RR*** (95% CI)	**p-value**
Maternal outcomes						
Vaginal birth	vaginal birth	263 (84.3)	171 (82.2)	92 (88.5)	1.08 (0.98 - 1.18)	0.13
PPH	>1 litre	165 (52.9)	115 (55.3)	50 (48.1)	0.87 (0.69 – 1.1)	0.24
Anal sphincter trauma	yes	22 (7.1)	12 (5.8)	10 (9.6)	1.67 (0.74 – 3.73)	0.22
Length of hospitalisation	1 day	141 (45.2)	98 (47.1)	43 (41.4)	1.13 (0.86 – 1.49)	
	2-3 days	117 (37.5)	75 (36.1)	42 (40.4)	0.89 (0.66 – 1.19)	
	4-5 days	30 (9.6)	19 (9.1)	11 (10.6)	0.86 (0.42 – 1.74)	
	6+ days	20 (6.4)	13 (6.3)	7 (6.7)	0.92 (0.38 – 2.25)	
	unknown	4 (1.3)	3 (1.4)	1 (1.0)		
Anaemia	yes	14 (4.5)	6 (2.9)	8 (7.7)	2.65 (0.94 – 7.46)	0.06
	unknown	1 (0.3)	1 (0.5)	0 (0.0)		
Maternal Sepsis	yes	19 (6.1)	11 (5.3)	8 (7.7)	1.45 (0.60 – 3.49)	0.41
	unknown	1 (0.3)	1 (0.5)	0 (0.0)		
Other complication	yes	12 (3.9)	7 (3.4)	5 (4.8)	1.42 (0.46 – 4.38)	0.54
	unknown	1 (0.3)	1 (0.5)	0 (0.0)		
Neonatal outcomes						
Cord gas (pH)	<7.1	41 (13.1)	23 (11.1)	18 (17.3)	1.50 (0.85 – 2.63)	0.16
	unknown	44 (14.1)	32 (15.4)	12 (11.5)		
Apgar@1mn	<=3	8 (2.6)	2 (1.0)	6 (5.8)	5.94 (1.22 – 29.00)	0.028
	unknown	5 (1.6)	4 (1.9)	1 (1.0)		
Apgar@5mn	<7	7 (2.2)	3 (1.4)	4 (3.9)	2.65 (0.6 – 11.66)	0.19

	unknown	4 (1.3)	3 (1.4)	1 (1.0)		
Apgar@10mn	<7	4 (1.3)	2 (1.0)	2 (1.9)	1.99 (0.28 – 13.97)	0.49
	unknown	4 (1.3)	3 (1.4)	1 (1.0)		
Shoulder dystocia	yes	42 (13.5)	22 (10.6)	20 (19.2)	1.82 (1.04 – 3.18)	0.04
TTN	yes	6 (1.9)	4 (1.9)	2 (1.9)	0.99 (0.18 – 5.31)	0.99
Cephalohaematoma	no	309 (99.0)	205 (98.6)	104 (100.0)	∞	
	unknown	3 (1.0)	3 (1.4)	0 (0.0)		
Facial palsy	no	308 (98.7)	204 (98.1)	104 (100.0)	∞	
	yes	1 (0.3)	1 (0.5)	0 (0.0)		
	unknown	3 (1.0)	3 (1.4)	0 (0.0)		
Jaundice	yes	11 (3.5)	9 (4.3)	2 (1.9)	0.44 (0.10 – 2.00)	0.29
	unknown	3 (1.0)	3 (1.4)	0 (0.0)		
Neonatal sepsis	yes	13 (4.2)	6 (2.9)	7 (6.7)	2.3 (0.79 – 6.68)	
	unknown	3 (1.0)	3 (1.4)	0 (0.0)		0.12
Other complication	yes	13 (4.2)	8 (3.9)	5 (4.8)	1.23 (0.41 – 3.68)	0.71
	unknown	3 (1.0)	3 (1.4)	0 (0.0)		
NICU admission	admitted	26 (8.3)	17 (8.2)	9 (8.7)	1.03 (0.48 – 2.24)	0.93
	unknown	5 (1.6)	5 (2.4)	0 (0.0)		

*assessed with log-binomial regression